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On the Theory of Saturn and the Mass of Jupiter.

M. Leverrier has communicated to the Academy of Sciences at Paris (*Comptes Rendus*, t. 81, pp. 349 and 381, August 23 and 30, 1875,) two Notes on the Comparison of his theory of *Saturn* with observations, and on the Mass of *Jupiter*.

As regards *Saturn*, the general result is that during the thirty-two years of modern observations, from 1837 to 1869, the difference between theory and observation is always below $2''\cdot5$ of arc (less than $0^s\cdot2$ in the times of transit), with the exception of the two years 1839 and 1844, for which the differences attain to $4''\cdot5$ of arc ($0^s\cdot3$ in the times of transit). It is only in the ancient observations, in the times of Maskelyne and Bradley, that there are some rather larger differences.

The accordance is thus good from 1846 to 1869; the only disquieting circumstance is in the somewhat abrupt change in five years, from a difference of $+4''\cdot4$ in 1839 to $-5''\cdot0$ in 1844, a change of $9''\cdot9$ in five years, according to the Greenwich Observations, or $9''\cdot5$ according to the Paris Observations. M. Leverrier is led to conclude ("nous sommes porté à conclure") that the error is due not to the theory, but to the observations: he considers that the varying aspects of the ring may have affected the observations of the times of transit, and have produced in the personal equations of the observers perturbations sensible enough in the ancient observations, but which have gradually diminished with the improvement in the system of observations.

As regards the Mass of *Jupiter*, Laplace (1802), from observations by Pound of the elongation of the fourth satellite, obtained the value $\frac{1}{1067\cdot09}$: Bouvard (1824), by means of his tables founded on the formulæ of the *Mécanique Celeste*, and by a comparison of the motions of *Jupiter*, *Saturn*, and *Uranus*,

with the observations during seventy-four years (1747 to 1820), obtained the value $\frac{1}{1070{\cdot}5}$; and Airy (1835), by a new series of observations of the fourth satellite, the value $\frac{1}{1046{\cdot}77}$: this last, and $\frac{1}{1050}$, are the values used in M. Leverrier's comparison of the theories of *Saturn* with the observations.

M. Leverrier inquires how it was that Bouvard was able to derive from the theory of Saturn compared with the observations of seventy-four years an inexact value of the mass of *Jupiter*; and one so nearly the same with that given by Pound's observations of the fourth satellite.

Using the 120 years of observation at his disposal in an attempt to find a correction of the mass of *Jupiter*, he finds that the influence of the indeterminate correction, μ^{iv}, of this mass, on the four elements, mean longitude, mean motion, eccentricity, and longitude of perihelion, is considerable; but, nevertheless, the form of the equations is such that on eliminating from the equations of condition the principal unknown quantities, the coefficients of μ^{iv} in a great measure destroy each other in the residual equations, and assume values which are nowhere the tenth part of what they were in the original equations: and that thus the precision which might have been expected for the determination of μ^{iv}, that is the correction of the mass of *Jupiter*, disappears.

And this is the case even for the 120 years of observation, while Bouvard had only the observations of 74 years: the data for Bouvard's investigation were thus absolutely insufficient.

How then did it happen that he found nearly the same mass as had been obtained from the early observations of the fourth satellite, thereby furnishing to Laplace the elements of an illusory calculation as to the great probability of the exactness of the results?

Bouvard gives no explanations of his process, but he must have started from the then received mass of *Jupiter*: and M. Leverrier considers that any mass whatever, assumed at pleasure within certain limits, permits of a sufficiently good satisfaction of the observations of *Saturn*, under the condition that this arbitrary mass is introduced consistently in the functions which represent the above-mentioned four elements; and that thus Bouvard could not but obtain for the mass a value nearly the same as his assumed one.

M. Leverrier's conclusion is: the employment of the elongations of the fourth satellite, for the determination of the mass of *Jupiter*, has at present an incontestable superiority over the employment of the theory of *Saturn*, on account of the insufficient period of the observations of *Saturn*: but in the course of years this superiority will diminish, and the employment of the observations of *Saturn* will have the advantage when, these perturbations having changed their sign, there remain in the

residual equations coefficients of μ^{iv} equal or superior to those of the original equations. The case is the same as in the question of the Sun's parallax, obtainable by the two methods, the transit of *Venus*, and the perturbations (for instance) of *Mars*: the method of Transits, so important at the epoch of 1760, but limited in its means, must give way ('doit fatalement céder la place') to the method of perturbations, the exactitude of which is continually increasing.

Remarks on Drawings of Jupiter made by Miss Hirst, at Auckland, New Zealand. By S. J. Lambert, Esq.*

On behalf of Miss Hirst, a lady resident in Auckland, New Zealand, who has been engaged in astronomical work for the last sixteen years, I beg to lay before the Royal Astronomical Society some of her notes on the last opposition of *Jupiter*, 1875.

The instrument she used was a Browning's $8\frac{1}{2}$-inch silvered-glass reflector, and the powers used were Browning achromatic eye-pieces of 144, 208, and 250. The information may be relied upon, as she is both a practical and a careful observer. She has made use of the diagrams used by Lord Rosse, in the *Monthly Notices* for March 1874, where the dark bands are designated by figures, and the bright spaces by letters. With these notes I send you a few of her drawings of *Jupiter*, all of which were made during the observations on the respective dates.

Her diary contains some valuable information on Meteoric Showers, observed in Auckland, which I will send you at some future time.

Zone 1.—The South Polar Zone has exhibited some signs of change during the recent opposition. On February 5, at $4^h\ 19^m$, G.M.T., this zone was seen divided longitudinally, near the pole of the planet; with aperture reduced to 6 inches, a number of small dark spots were visible on the surface of this zone, whose centres were extremely black. During this observation the definition was sharp, and the air steady. This zone has appeared decidedly fainter than last season. On February 20, at $3^h\ 59^m$, G.M.T., a small oval patch of a decided sea-green was visible a little to the east of the pole, which on the following morning was more elongated, and a shade darker in the centre. It remained thus for three days, and has not since been seen.

Zone *a*.—On many mornings lately, this bright band has been sharply defined. On March 17, at $2^h\ 36^m$, G.M.T., a dark streak, broken in two places, ran along the centre of this zone. Later on, in the morning, it became one continuous line, but of

* These drawings are preserved at the rooms of the Society, where they can be inspected by any Fellow desirous of comparing them with other drawings of *Jupiter*.